SECTION I.—AEROLOGY.

SOLAR AND SKY RADIATION MEASUREMENTS DURING JANUARY, 1918.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated: Washington, D. C., Feb. 27, 1918.]

INSTRUMENTS AND EXPOSURES.

In this REVIEW for January, 1916, 44: 2, will be found descriptions of the exposure of the Marvin pyrheliometer at the various stations, and an account of the method of obtaining and reducing the radiation measurements. These still apply, except as amended in the REVIEW for January, 1917, 45: 2, and with the further modification that during 1917 the establishment on the campus at the American University, of Camp American University and an extensive laboratory for the U. S. Bureau of Mines, has greatly increased the amount of local smoke in the lower atmosphere. The smoke does not rise to any considerable height, and is quickly cleared away by the wind, so that there is generally opportunity to obtain pyrheliometric readings during intervals when the sky is practically free from smoke.

As noted in the REVIEW for September, 1917, 45: 440, the spiral-ribbon type of Marvin pyrheliometer in use at Santa Fe, N. Mex., up to the end of April, 1917, has been replaced by a Marvin silver-block pyrheliometer. This latter, and also the Marvin pyrheliometers in use at Madison, Wis., and Lincoln, Nebr., were restandardized during October, 1917, by comparison with Smithsonian silver-disk pyrheliometer No. 1. Practically no change in the constants of these instruments was detected except in the one at Lincoln. The apparent change in the latter instrument, and the corrections to be applied to its readings, are given in the REVIEW for December, 1917, 45: 574.

In the REVIEW for January and April, 1916, 44: 4, 179–180, will be found descriptions of the exposure of the Callendar recording pyrheliometer at the different stations, and an account of the method by which records are reduced to heat units. These still apply, except as modified in the REVIEW for January, 1917, 45: 2.

At Lincoln, as stated in the REVIEW for May, 1917, the publication of the records of solar and sky radiation from the Callendar pyrheliometer, was temporarily suspended pending a redetermination of the constants of the instrument. As shown in the REVIEW for December, 1917, 45: 574, these constants, and the resulting corrections to back records, have been determined. A new bridge wire, carefully calibrated, was placed on the register at the end of October. The publication of the records of solar and sky radiation (Table 3) for Lincoln is therefore resumed with this number of the REVIEW.

The statements in the REVIEW for January, 1916, and 1917, 44: 2 and 45: 2, relative to skylight polarization measurements, and in the REVIEW for January, 1917, 45: 2, relative to "Radiation Normals" and "Solar constant determinations," still apply.

OBSERVATIONS DURING JANUARY, 1918.

Table 1 is a summary of the measurements made at the different stations with the Marvin pyrheliometer. The departures from normal values indicate that direct solar radiation intensities were very close to normal at Washington, and slightly below normal at the other three stations. Table 3 shows very nearly the normal amount of radiation at Washington and Lincoln, and a pronounced excess, as compared with the normal, at Madison during the latter part of the month.

No skylight polarization measurements were obtained at either Washington or Madison, as the ground was continuously covered with snow.

The readings of the Marvin pyrheliometer indicate steady sky conditions on only one morning at Washington, two mornings at Santa Fe, and one morning at Madison. Even on these most favorable mornings there was disturbance from local smoke at Madison and Santa Fe. The results of extrapolating to zero air mass, given in Table 4, should therefore be given little weight. Except for the one series at Madison they indicate low values for the solar constant.

TABLE 1.—*Solar radiation intensities during January, 1918.*

[Gram-calories per minute per square centimeter of normal surface.]

Washington, D. C.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
1918.										
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 3	.....	.....	1.28	1.16	1.14	1.11	1.05	1.00	0.96	0.92
4	.....	.....	1.37	1.28	1.20	1.13	1.05	1.00	0.95	0.91
8	.....	.....	.....	1.02	0.96	0.90	0.73	0.62	0.58	.....
17	.....	.....	.....	1.06	0.92	0.84	0.76	0.70	.....	.....
19	.....	.....	1.16	1.06	.....	0.88	0.80	0.73	0 64	0.60
21	.....	.....	1.14	1.05	0.93	0.83	0.73	0.65	0.60	.....
Monthly means	.....	.....	1.24	1.11	1.03	0.95	0.85	0.78	0.75	0.81
Departure from 10-year normal	.....	.....	+0.03	+0.02	+0.03	+0.02	−0.01	−0.01	+0.02	+0.11
P. M.										
Jan. 3	.....	.....	.....	1.09	0.98	.....	.....	.....	.....	.....
10	.....	.....	.....	1.15	1.03	0.94	0.86	0.79	.....	.....
12	.....	.....	.....	1.01	0.99	0.94	0.88	0.82	0.90	.....
19	.....	.....	.....	.....	.....	.....	0.86	0.90	.....	.....
21	.....	.....	.....	0.93	.....	.....	.....	.....	.....	.....
22	.....	.....	.....	1.21	1.16	1.11	1.06	0.98	.....	.....
Monthly means	.....	.....	.....	1.08	1.04	1.00	0.92	0.85	(0.86)	.....
Departure from 10-year normal	.....	.....	.....	−0.03	+0.00	+0.05	+0.03	+0.03	+0.03	.....

TABLE 1.—*Solar radiation intensities during January, 1918*—Contd.

Madison, Wis.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	65.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
1918.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
A. M.										
Jan. 14					1.39	1.30	1.22	1.15	1.10	
15				1.28					0.96	
19			1.28	1.15	1.02	0.91	0.82	0.73		
29				1.37	1.29	1.21	1.13	1.06	1.01	0.96
Monthly means			(1.28)	1.27	1.23	1.14	1.06	0.98	1.02	(0.96)
Departure from 8-year normal			−0.07	−0.08	−0.04	−0.03	−0.02	−0.01	−0.09	−0.00
P. M.										
Jan. 7							1.12			
8						1.24	1.22	1.19		
9					1.34	1.29		1.19		
19				1.15	1.02					
28				1.21	1.22	1.21	1.19			
31					1.34					
Monthly means				(1.20)	1.23	1.25	1.18	(1.19)		
Departure from 8-year normal				−0.11	−0.01	+0.06	+0.04	+0.05		

Lincoln, Nebr.

A. M.										
Jan. 3				1.06	0.92	0.80				
4					1.01	0.97	0.93	0.89		
7				1.25	1.16	1.08				
11				1.39	1.33	1.26				
14				1.37						
23			1.36							
28			1.30							
Monthly means			(1.33)	1.27	1.10	1.03	(0.93)	(0.89)		
Departure from 3-year normal			−0.06	−0.02	−0.10	−0.10	−0.14	−0.11		
P. M.										
Jan. 3					0.99	0.89	0.91	0.75		
12				1.32	1.27	1.20	1.14	1.07	1.02	
14				1.29	1.24	1.20	1.16	1.11	1.07	1.04
23				1.27	1.25	1.22	1.13	1.06		
Monthly means				1.29	1.19	1.13	1.06	1.00	(1.04)	(1.04)
Departure from 3-year normal				−0.03	−0.05	−0.07	−0.07	−0.06	−0.02	

Santa Fe, N. Mex.

A. M.										
Jan. 4						1.28				
16							1.24			
21				1.34						
22			1.51	1.44	1.35	1.26				
23			1.50			1.24				
24			1.49	1.42		1.29				
29		1.52	1.45	1.38	1.32	1.26				
30					1.36	1.28				
Monthly means		(1.52)	1.49	1.40	1.34	1.27	(1.24)			
Departure from 6-year normal		−0.03	−0.02	−0.03	−0.05	−0.05	−0.04			
P. M.										
Jan. 22							1.15			
29				1.33						
Monthly means				(1.33)			(1.15)			
Departure from 2-year normal				−0.06			−0.05			

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D. C.			Madison, Wis.			Lincoln, Nebr.			Santa Fe, N. Mex.		
Date.	8 a. m.	8 p. m.	Date.	8 a. m.	8 p. m.	Date.	8 a. m.	8 p. m.	Date.	8 a. m.	8 p. m.
1918.	mm.	mm.	1918.	mm.	mm.	1918.	mm.	mm.	1918.	mm.	mm.
Jan. 3	0.97	1.02	Jan. 7	1.88	1.45	Jan. 3	1.96	2.87	Jan. 4	3.30	4.37
4	0.74	0.86	8	0.91	1.19	4	3.09	4.37	16	1.78	2.49
8	1.96	1.52	9	0.74	1.19	7	0.97	2.06	21	0.86	1.96
10	1.88	2.06	14	0.64	0.79	11	0.28	0.23	22	0.91	1.78
12	4.75	1.25	15	0.56	0.86	12	0.53	0.81	23	1.88	2.26
17	3.15	2.62	19	0.58	0.97	14	0.74	1.37	24	1.45	2.87
19	1.19	1.07	28	1.45	1.12	23	2.62	3.99	29	1.19	2.36
21	1.19	1.60	29	0.64	0.71	28	0.46	1.02	30	1.78	2.49
22	2.36	2.06	31	0.46	0.53						

TABLE 3.—*Daily totals and departures of solar and sky radiation during January, 1918.*

[Gram-calories per square centimeter of horizontal surface.]

Day of month.	Daily totals.			Departures from normal.			Excess of deficiency since first of month.		
	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.	Washington.	Madison.	Lincoln.
1918.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
Jan. 1	224	28	122	62	−116	−58	62	−116	−58
2	94	143	135	−68	−3	−47	−6	−119	−105
3	242	101	201	79	−46	18	73	−165	−87
4	244	146	180	81	−2	−5	154	−167	−92
5	108	51	35	−55	−98	−151	99	−265	−243
6	92	36	122	−72	−115	−66	27	−380	−309
7	49	216	367	−115	61	178	−88	−319	−131
8	224	233	84	59	78	−107	−29	−237	−238
9	121	226	210	−45	70	17	−74	−167	−221
10	233	190	296	67	3	101	−7	−164	−120
11	60	114	118	−107	−45	−79	−114	−209	−199
12	208	143	276	40	−18	77	−74	−227	−122
13	255	248	216	86	85	15	12	−142	−107
14	108	229	266	−62	64	63	−50	−78	−44
15	119	245	205	−52	78	0	−102	0	−44
16	195	203	206	22	93	−2	−80	93	−46
17	237	256	231	63	84	19	−17	177	−27
18	210	272	207	34	105	−8	17	282	−35
19	226	252	176	49	75	−43	66	357	−78
20	230	246	217	51	67	−5	117	424	−83
	Decade departure						+124	+589	+37
21	272	166	267	91	−15	41	208	409	−42
22	152	272	241	−31	88	12	177	497	−30
23	245	116	248	60	−70	15	237	427	−15
24	216	194	227	59	6	−9	296	433	−24
25	148	262	128	−41	71	−112	255	504	−136
26	139	128	183	−53	−65	−60	202	439	−196
27	74	217	86	−120	21	−161	82	460	−357
28	57	228	325	−139	30	75	−57	490	−282
29	283	259	271	84	58	17	27	548	−265
30	40	202	324	−161	−1	67	−134	547	−198
31	175	323	254	−28	117	−6	−162	664	−204
	Decade departure						−279	+240	−121
Excess or deficiency since first of year.	cal.								
	per cent.						−3.0	+12.5	−3.1

TABLE 4.—*Solar radiation intensities for zenithal sun, reduced to mean solar distance of the earth, and resulting approximate values of the solar constant.*

[Gram-calories per minute per square centimeter of normal surface.]

Stations.	Dates.	Radiation Intensity.		Solar Constant.
		m=1	m=0	
	1918.	calories.	calories.	calories.
Washington, D. C.	Jan. 4	1.50	1.70	1.76
Santa Fe, N. Mex.	Jan. 24	1.60	1.76	1.85
	Jan. 29	1.55	1.70	1.78
Madison, Wis.	Jan. 29	1.61	1.85	1.91